

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Service, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC 20503.				
PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.				
1. REPORT DATE (DD-MM-YYYY) 01-05-2012		2. REPORT TYPE Master of Military Studies Research Paper		3. DATES COVERED (From - To) September 2011 - April 2012
4. TITLE AND SUBTITLE Is the F-35B the right fit for the MAGTF?			5a. CONTRACT NUMBER N/A	
			5b. GRANT NUMBER N/A	
			5c. PROGRAM ELEMENT NUMBER N/A	
6. AUTHOR(S) Lieutenant Commander Christopher S. Williams, USN			5d. PROJECT NUMBER N/A	
			5e. TASK NUMBER N/A	
			5f. WORK UNIT NUMBER N/A	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) USMC Command and Staff College Marine Corps University 2076 South Street Quantico, VA 22134-5068			8. PERFORMING ORGANIZATION REPORT NUMBER N/A	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A			10. SPONSOR/MONITOR'S ACRONYM(S) N/A	
			11. SPONSORING/MONITORING AGENCY REPORT NUMBER N/A	
12. DISTRIBUTION AVAILABILITY STATEMENT Unlimited				
13. SUPPLEMENTARY NOTES N/A				
14. ABSTRACT Future Department of Defense (DoD) budget reductions with operational requirements remaining the same are forcing the services to make hard decisions. In the future austere budget environment following the defense budget drawdown, the Marine Corps should explore options other than the F-35B to fulfill the requirements of the Aviation Combat Element. The focus of this paper will explore the possibility of reshaping the Aviation Combat Element (ACE) in order to meet the current problems of today with a solution for the Marine Ground Task Force (MAGTF) for future operations.				
15. SUBJECT TERMS F-35B, STOVL, V/STOL, ACE, MAGTF				
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 46
a. REPORT Unclass	b. ABSTRACT Unclass	c. THIS PAGE Unclass		
19a. NAME OF RESPONSIBLE PERSON Marine Corps University / Command and Staff College			19b. TELEPHONE NUMBER (Include area code) (703) 784-3330 (Admin Office)	

INSTRUCTIONS FOR COMPLETING SF 298

1. REPORT DATE. Full publication date, including day, month, if available. Must cite at least the year and be Year 2000 compliant, e.g., 30-06-1998; xx-08-1998; xx-xx-1998.

2. REPORT TYPE. State the type of report, such as final, technical, interim, memorandum, master's thesis, progress, quarterly, research, special, group study, etc.

3. DATES COVERED. Indicate the time during which the work was performed and the report was written, e.g., Jun 1997 - Jun 1998; 1-10 Jun 1996; May - Nov 1998; Nov 1998.

4. TITLE. Enter title and subtitle with volume number and part number, if applicable. On classified documents, enter the title classification in parentheses.

5a. CONTRACT NUMBER. Enter all contract numbers as they appear in the report, e.g. F33615-86-C-5169.

5b. GRANT NUMBER. Enter all grant numbers as they appear in the report, e.g. 1F665702D1257.

5c. PROGRAM ELEMENT NUMBER. Enter all program element numbers as they appear in the report, e.g. AFOSR-82-1234.

5d. PROJECT NUMBER. Enter all project numbers as they appear in the report, e.g. 1F665702D1257; ILIR.

5e. TASK NUMBER. Enter all task numbers as they appear in the report, e.g. 05; RF0330201; T4112.

5f. WORK UNIT NUMBER. Enter all work unit numbers as they appear in the report, e.g. 001; AFAPL30480105.

6. AUTHOR(S). Enter name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. The form of entry is the last name, first name, middle initial, and additional qualifiers separated by commas, e.g. Smith, Richard, Jr.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES). Self-explanatory.

8. PERFORMING ORGANIZATION REPORT NUMBER. Enter all unique alphanumeric report numbers assigned by the performing organization, e.g. BRL-1234; AFWL-TR-85-4017-Vol-21-PT-2.

9. SPONSORING/MONITORS AGENCY NAME(S) AND ADDRESS(ES). Enter the name and address of the organization(s) financially responsible for and monitoring the work.

10. SPONSOR/MONITOR'S ACRONYM(S). Enter, if available, e.g. BRL, ARDEC, NADC.

11. SPONSOR/MONITOR'S REPORT NUMBER(S). Enter report number as assigned by the sponsoring/ monitoring agency, if available, e.g. BRL-TR-829; -215.

12. DISTRIBUTION/AVAILABILITY STATEMENT. Use agency-mandated availability statements to indicate the public availability or distribution limitations of the report. If additional limitations/restrictions or special markings are indicated, follow agency authorization procedures, e.g. RD/FRD, PROPIN, ITAR, etc. Include copyright information.

13. SUPPLEMENTARY NOTES. Enter information not included elsewhere such as: prepared in cooperation with; translation of; report supersedes; old edition number, etc.

14. ABSTRACT. A brief (approximately 200 words) factual summary of the most significant information.

15. SUBJECT TERMS. Key words or phrases identifying major concepts in the report.

16. SECURITY CLASSIFICATION. Enter security classification in accordance with security classification regulations, e.g. U, C, S, etc. If this form contains classified information, stamp classification level on the top and bottom of this page.

17. LIMITATION OF ABSTRACT. This block must be completed to assign a distribution limitation to the abstract. Enter UU (Unclassified Unlimited) or SAR (Same as Report). An entry in this block is necessary if the abstract is to be limited.

United States Marine Corps
Command and Staff College
Marine Corps University
2076 South Street
Marine Corps Combat Development Command
Quantico, Virginia 22134-5068

MASTER OF MILITARY STUDIES

TITLE:

Is the F-35B the right fit for the MAGTF?

SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF MILITARY STUDIES

AUTHOR:

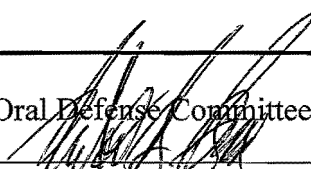
Lieutenant Commander Christopher S. Williams, USN

AY 11-12

Mentor and Oral Defense Committee Member:

Approved:

Date:

 Robert B. Bruce, Ph.D.
30 April 2012

Oral Defense Committee Member:

Approved:

Date:


 Bradford A. Wineman
1 May 2012

Table of Contents

	Page
DISCLAIMER	iii
Executive Summary	iv
Illustrations	v
Introduction.....	1
Background.....	2
The Marine Corps Mission	2
Marine Air Ground Task Force.....	3
Aviation Combat Element.....	4
Mission.....	4
Aircraft.....	5
The Fixed-wing Tactical Aviation Dilemma	5
Service Life/ Strike-fighter Shortfall	6
Budget Environment	7
The Current Solution.....	9
F-35B	9
ACE Game Changer?.....	11
Alternative Solution	13
CTOL-F-35C or F/A-18E-F “Super Hornet”	14
Rotary-Wing	16
Unmanned Aircraft Systems (UAS)	19
Conclusion	21
Appendix A: Defense Budget Over Time.....	23
Appendix B: MAGTF Capability	24
Appendix C: ACE Missions.....	25
Appendix D: JSF Family of Aircraft	27

Appendix E: F/A-18 Super vs. Legacy Comparison	28
Appendix F: H-1 Upgrades	30
Appendix G: AGM-114 Hellfire.....	32
Appendix H: USMC UAS	33

DISCLAIMER

THE OPINIONS AND CONCLUSION EXPRESSED HEREIN ARE THOSE OF THE INDIVIDUAL STUDENT AUTHOR AND DO NOT NECESSARILY REPRESENT THE VIEWS OF EITHER THE MARINE CORPS COMMAND AND STAFF COLLEGE OR ANY OTHER GOVERNMENTAL AGENCY. REFERENCES TO THIS STUDY SHOULD INCLUDE THE FOREGOING STATEMENT.

QUOTATION FROM, ABSTRACTION, OR REPRODUCTION OF ALL OR ANY PART OF THIS DOCUMENT IS PERMITTED PROVIDED PROPER ACKNOWLEDGEMENT IS MADE

Executive Summary

Title: Is the F-35B the right fit for the MAGTF?

Author: Lieutenant Commander Christopher S. Williams, United States Navy

Thesis: The acquisition of the F-35B could adversely affect, and limit, the Marine Corp's ability to execute its self-defined role as the nation's 911 and middleweight force; therefore the service should seek other viable alternatives to accomplish the future mission.

Discussion: Future Department of Defense (DoD) budget reductions with operational requirements remaining the same are forcing the services to make hard decisions. In the future austere budget environment following the defense budget drawdown, the Marine Corps should explore options other than the F-35B to fulfill the requirements of the Aviation Combat Element. The focus of this paper will explore the possibility of reshaping the Aviation Combat Element (ACE) in order to meet the current problems of today with a solution for the Marine Ground Task Force (MAGTF) for future operations. The Fixed-wing tactical aviation assets of the ACE are rapidly reaching their service life (i.e. AV-8B, EA-6B, F/A-18A-D) requiring replacements in order to support the ACE mission of the MAGTF. The current replacement solution for the Marine Corps is the F-35B and F-35C Lightning II, consolidating three separate models of tactical aircraft into a fifth generation strike fighter. The F-35 provides "Day One" stealthy long-range interoperability, which deploys from main operating bases, aircraft carriers, and amphibious ships. Although the capabilities of the F-35B look to modernize an aging fleet, the cost of the F-35B possibly marginalizes the capability gained. There are alternative solutions to the F-35B that are cheaper and, in some cases, just as effective for the desired mission of the ACE.

Conclusion: Defense budget reductions are requiring services to make hard choices in terms of resources in order save money while continuing the present mission. The reduction of funds combined with maintaining the current requirements, carries significant inherent risk. The key to successful future force shaping will be determining a solution which meets the mission requirements while mitigating various levels of risk. While the F-35B provides tremendous overall capability, the cost associated with procuring and maintaining this capability could possibly hinder the Marine Corp's ability to execute expeditionary operations. The alternatives mentioned in this paper represent viable cost effective solutions that, if implemented today, could pay off in future operations. The current and future solutions discussed carry varying degrees of risk during implementation.

Illustrations

Page

Figure 1. Composition of the MAGTF.....	4
Figure 2. Procurement of Navy and Marine Corps Strike-Fighters.....	7
Figure 3. Changes in Procurement Plans over Time.....	11

Introduction

This paper explores the possibility of reshaping the Aviation Combat Element (ACE), in particular the fixed-wing element, in order to address the current issues with a solution that will streamline the Marine Ground Task Force (MAGTF) for future operations. The fixed-wing tactical aviation assets of the ACE are rapidly reaching their service life (i.e. AV-8B, EA-6B, F/A-18A-D) requiring replacements in order to support the ACE mission of the MAGTF. The current replacement solution for the Marine Corps is the F-35B and F-35C Lightning II, consolidating three separate models of tactical aircraft into a fifth generation strike fighter. The F-35 provides "Day One" stealthy long-range interoperability, which deploys from main operating bases, aircraft carriers, and amphibious class ships. Although the capabilities of the F-35B look to modernize an aging fleet, the cost of the F-35B possibly marginalizes the capability gained. There are alternative solutions to the F-35B that are cheaper and, in some cases, just as effective for the ACE mission. The cost of the F-35B versus the capability gained is excessive and unwarranted in the future threat environment. Potential alternatives would provide a significant savings to the Marine Corps (for possible reinvestment into MAGTF enhancing projects such as the Expeditionary Fighting Vehicle) and the Department of Defense. The acquisition of the F-35B by the Marine Corps has the potential to become cost prohibitive and provide a disproportionate capability unnecessary to executing its self-defined role as the "nation's 911" and "middleweight force".

Fiscal austerity and economic downturn in the United States economy has forced the current administration to reevaluate future federal spending. "To that end, the Budget Control Act of 2011 mandates reductions in federal spending, including defense spending."¹ The notion of a peace dividend is nothing new to the United States Department of Defense (DoD) ([see](#)

[Appendix A](#)). The key issue of concern is not if funding cuts will occur, but the amount decreased, and how that will translate to force reshaping. The challenges in defense reduction manifest themselves while executing the priorities of the national strategy with acceptable risk. The principle idea of defense budget reductions is to avoid the "hollow force" syndrome as witnessed post-Vietnam War.² Therefore, the key to survival throughout the years of budgetary downturn necessitates an accurate assessment of core requirements. With soaring budget deficits, it is prudent to question federal defense spending. The common rhetoric amongst government leaders revolves around increasing efficiency and eliminating redundancy within the DoD in order to help manage and reduce the deficit.³ Likewise, service component leaders strive to maintain capability while managing budget decreases through a reduction in capacity.

As DoD funding quickly evaporates, many service components scramble to justify funding through a return to core competencies. The umbrella of core competencies does not guarantee full funding of requirements, but it appears to be a viable strategy to avoid further deep cuts in the upcoming budget reduction. Efforts outside of a service components' core competency presents the perception of redundancy and possible inefficiency. The Marine Corps, in particular, has operated outside its service core competency for the past 10 years by contributing to significant sustained combat operations in Iraq and Afghanistan. These recent events possibly make the Marine Corps vulnerable regarding questions of relevancy in a period of defense reduction.

Background

The Marine Corps Mission

The United States Marine Corps (USMC) has served as an expeditionary force organized and trained to act in the national security interest of the United States and carry out the national military strategy. Unlike the other military services, the USMC does not lay claim to a specific

domain (i.e. Air Force operates predominately in the Air/Space domain, Navy predominately in the Maritime domain). The Marine Corps' ability to successfully operate expeditionary has created a niche necessary for the Corps' relevancy to national security. The Marine Corps satisfies the national requirement for an expeditionary force-in-readiness that can rapidly respond to a crisis anywhere in the world.

The five core competencies that define Marine Corps capabilities and facilitate USMC contributions to the National Military Strategy are as follows: War-fighting Culture and Dynamic Decision-making, Expeditionary Forward Operations, Sustainable and Interoperable Littoral Power Projection, Combined Arms Integration, and Forcible Entry from the Sea.⁴ The Marine Corps provides self-sustainable, task organized combined arms forces capable of conducting a full spectrum of operations in the form of the Marine Air Ground Task Force (MAGTF). The MAGTF incorporates a balanced, air-ground combined arms task organization of Marine Corps assets under a single commander, structured to accomplish a specific mission. The Marine Corps employs the MAGTF as the primary organization for various missions across the range of military operations. MAGTFs vary in composition based upon the specific mission but are all tailored for rapid deployment by air or sea ([see Appendix B](#)).

Marine Air Ground Task Force

Although MAGTFs differ in size and capability, all consist of a similar modular design of four core elements: a command element (CE), a ground combat element (GCE), an aviation combat element (ACE), and a logistics combat element (LCE). The MAGTF ability to operate autonomously without external support or in the joint environment yields a unique tool in crisis response. The capabilities of the entire MAGTF as a whole far outweigh the abilities of the individual elements.

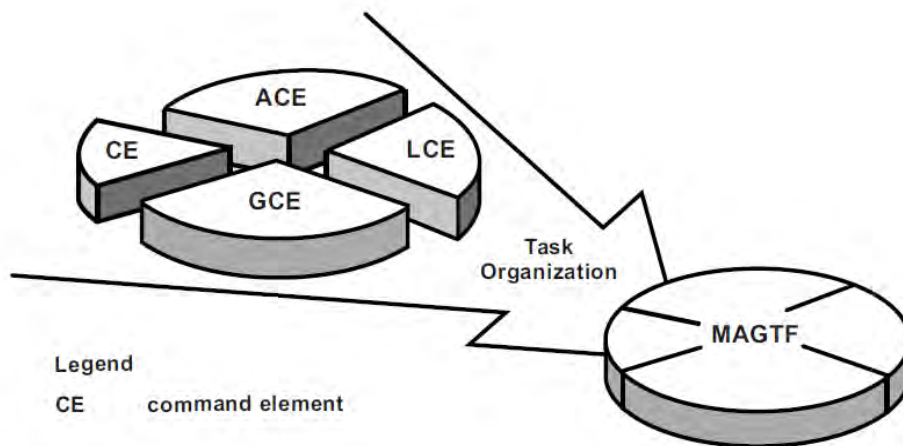


Figure 1: Composition of the MAGTF
 Source: *Marine Corps Operations (MCDP 1-0)*

Although the MAGTF consists of four elements, there are two primary combat elements (GCE and ACE), and one support element (LCE). In theory, any one of the three employable elements can be the supported effort (main effort) depending on the task, but typically, the GCE tends to be the principal supported effort. Therefore, the remaining elements (ACE, LCE) of the MAGTF predominantly fill supporting roles.

Aviation Combat Element

Mission

The ACE provides the MAGTF with the modern day technology to extend the combat reach of the GCE in support of the overall MAGTF objectives. Aviation assets enable the MAGTF to conduct various operations across the spectrum of military operations primarily through mobility and firepower. By extending the limited range of ground and ship based fires, the ACE enables the MAGTF commander to conduct the deep fight in order to shape forward operations. The ACE provides the following capabilities to the MAGTF: delivery of fires, integrated command and control, mobility and maneuver, force protection, sustained combat power, and intelligence collection.⁵ These capabilities originate from six core functional areas of

Marine Aviation: offensive air support (OAS), anti-air warfare (AAW), assault support, air reconnaissance, electronic warfare (EW), and control of aircraft and missiles ([see Appendix C](#)).

Aircraft

The ACE accomplishes the five primary kinetic missions through a variety of fixed-wing, rotary-wing, and unmanned aerial assets. The fixed-wing assets include: F/A-18, AV-8, E/A-6, and KC-130. The rotary-wing assets include: AH-1, UH-1, CH-46, CH-53 and MV-22 (Tilt-rotor). Unmanned aerial vehicle assets include: RQ-7 and Scan Eagle.

The Fixed-wing Tactical Aviation Dilemma

Marine Corps' fixed-wing tactical aviation has a problem that continues to worsen over time. The EA-6B, F/A-18, and the AV-8B are Marine assets that entered service in the 1970s and 1980s. Typical service life associated with fixed-wing tactical airframes ranges from 20 to 30 years due to the stress of tactical maneuvering during missions. Flight hours dictate actual fatigue limits on airframes, which also drives maintenance actions/inspections. In 1992, Marine aviation leadership made a conscious decision to not participate in the F/A-18 (E-F) Super Hornet procurement, leaving the Marines very few maneuvering options until the arrival of the Joint Strike Fighter. The Navy realized the service life of their legacy F/A-18 would not last to the Joint Strike Fighter (JSF) initial operational capability (IOC), therefore elected to procure the F/A-18 E-F as a bridge to the JSF. This decision to continue the use of the F/A-18 through the procurement of the Super Hornet allowed the Navy the option to purchase additional Super Hornets at a unit cost of \$66.9 million (flyaway cost), in comparison to the price tag of the legacy F/A-18 (A-D) of approximately \$55 million (flyaway cost).⁶

Service Life/ Strike-fighter Shortfall

The health of Marine F/A-18s remains a crucial element of the TACAIR dilemma. Currently, the Center Barrel Replacement Plus program has extended the life of the Lot 17 and below aircraft to 1.0 Wing Root Fatigue Life.⁷ Engineers of the legacy F/A-18 designed the service life of the airframe to guarantee performance to a fatigue life of 6,000 flight hours. Service life extension programs (SLEP) have successfully extended the airframe life out to 8,000 flight hours, while additional inspections and repairs have added another 600 hours to the airframe bringing the total flight hours available on legacy F/A-18 airframes to 8,600.⁸

In November 2007, Commander, Naval Air Forces (CNAF) and DC(A) released a message outlining a program to better manage our use of Hornet service life. Under this program, service life is managed for each individual aircraft enabling a more comprehensive and efficient approach to aircraft service life preservation. In addition, the Service Life Assessment Program (SLAP) will determine investments required to extend the F/A-18 A+/C/D to 10,000 Flight Hours. Earlier phases of this program extended the catapult and landing limits of the A+/C/D to 2700 and 14,500 respectively (1500 catapults and 17,000 landing for the F/A-18D).⁹

These figures are significant since operational requirements for the past 10 years have demanded a higher operational tempo which resulted in higher usage rate of Marine aviation assets.

Meanwhile as the legacy F/A-18 realizes accelerated fatigue, the JSF has encountered many issues that have delayed delivery to the fleet, thus creating a gap between F/A-18 service life completion and F-35 IOC. The last decade of operations has caused an accelerated utilization of strike fighter assets in the Department of Navy and Marine Corps. The Department of the Navy's current inventory of strike-fighter aircraft falls short of the operational requirement to fully support carrier air wings (CVW) and Marine air wings (MAW). The deficit will peak in FY2017 with a projected deficit of 125 aircraft. These projections are based on two key assumptions that may not hold true based on recent developments. The first assumption consists of extending all F/A-18 Hornet airframes from 6,000 flight hours to 10,000 flight hours. Recent development in the service-life extension program (SLEP) reveals that this may net far less gain than initially

projected.

	FY07	FY08	FY09	FY10	FY11	FY12	FY13
<i>F/A-18E/F Super Hornet (USN)</i>							
Quantity	37	24	23	18	17	22	0
Total proc. cost	\$2,766	\$2,106	\$1,920	\$1,631	\$1,581	\$1,735	\$200
Unit proc. cost	\$75	\$88	\$83	\$91	\$93	\$79	—
<i>F-35 Lightning II</i>							
Quantity (total)	0	6	8	18	19	40	42
F-35C (USN)	0	0	0	4	6	15	17
F-35B (USMC)	0	6	8	14	13	25	25
Total proc. cost ^a	\$124	\$1,224	\$1,896	\$3,565	\$3,376	\$5,640	\$5,613
Unit proc. cost ^a	—	\$204	\$237	\$198	\$178	\$141	\$134

Source: FY2009 DON budget submission.

Figure 2: Procurement of Navy and Marine Corps Strike-Fighters, FY2007-FY2013

The second assumption requires an increasing production rate that eventually reaches a sustained rate of 50 aircraft per year. Considered optimistic from the beginning, the recent delays of the JSF program have further exacerbated the strike-fighter shortfall. If the sustained F-35 procurement rate turns out to be 35 aircraft per year rather than 50 per year, the projected DON strike-fighter shortfall would increase to more than 120 aircraft in FY2016, more than 160 aircraft in FY2017.¹⁰ Currently, there are less than 10 JSF flying and not a single aircraft delivered to the fleet in an operational status. This delay in F-35 production creates a problem in strike-fighter availability as legacy F/A-18s rapidly reaches the end of their service life.

Budget Environment

The Deputy Secretary of Defense, William Lynn III, in a 17 March 2011 speech, identified four major lessons from previous DoD budget reductions.

"The first is to make the hard decisions early; alluding to the fact that if we cannot afford it today, than mostly likely we will not be able to afford it in the future.

Second, the idea of efficiencies will not generate the savings necessary to meet the deficit reduction targets. Third, reductions are a reality, but the key is to balance the cuts amongst the available resources. We cannot afford to mortgage personnel, investment, or training accounts exclusively to find required savings. We cannot afford a “procurement holiday” as we experienced in the 1980s or creating a hollow force by divesting of operations and maintenance dollars. Fourth, do not cut too much too fast. We must find the courage to maintain capability in core mission areas and aggressively divest or reduce capacity in lesser mission areas.”¹¹

The budgetary plan moving forward as outlined by the Obama Administration seeks to intelligently downsize the military in an attempt to shape the force for future combat operations. Although defining the landscape of future combat operations remains a difficult task, what remains more challenging is agreeing to a force that is able to manage the risk of downsizing while satisfying the goals set forth in the National Security Strategy of the United States. One of the most significant assumptions to arise from the Defense Strategic Guidance is the idea of no longer seeking to maintain the ability to fight two major combat operations simultaneously. As the DoD budget shrinks by \$487 billion, defining the limits of military operations becomes paramount in order to avoid the idea of the hollow force structure. Constructing a DoD structured to engage in a single major combat operation dictates a leaner force centered upon joint execution of the services in order to take advantage of their unique capabilities. As joint operations and efficiency increase, it is likely to encounter redundant capability. The elimination of these redundant capabilities will continue the progression towards a leaner force while leveraging joint execution. Unnecessary redundancy within services creates a natural barrier to joint operations. In an austere future budget environment, the Marine Corps must choose between *nice-to-have* and *need-to-have*. Maintaining redundant capabilities reduces funds for, and degrades capability of, assets that are capable of filling the Marine Corps need in a joint environment.

The Current Solution

F-35B

The Marine Corps' current solution to the tactical fixed-wing aviation dilemma is the F-35B Short Take-Off Vertical Landing (STOVL) and F-35C Carrier Take-Off Landing (CTOL) variants of the JSF ([see Appendix D](#)). The F-35B will replace all three Marine fixed-wing tactical platforms: F-18A-D, AV-8B, and EA-6B. The F-35B is a single-engine, single-seat aircraft with acceleration and velocity capability comparable to legacy F/A-18s. The combination of sensor fusion and low observable radar signature create the 5th generation capability that separates JSF from legacy aircraft. While the individual components of technology increase capability, the true leap in performance is generated in the fusing of many of the advanced systems to create a single picture of situational awareness. Therefore, this 5th generation capability provides the commander a stealthy, supersonic, multi-role fighter able to execute air-to-air and air-to-ground missions in high threat areas.

The JSF program emerged in 1995 from the Joint Advanced Strike Technology (JAST) program, which commenced in 1993 because of the Department of Defense Bottom-Up Review of major acquisition programs. In 1994, the JAST program came under heavy scrutiny for merely developing technology vice focusing efforts to develop and procure new aircraft. Following these events, Congress attempted to consolidate the focus of DoD efforts for future procurement of tactical aircraft under one umbrella, the JSF program. The JSF aimed to consolidate the numerous independent service tactical aircraft replacement programs in order to focus joint development and production of a next-generation fighter/attack plane.¹² Consolidating the programs across the DoD allowed for integration of technology and, most important, cost efficacy. The JSF project called for a production of 2,457 aircraft in three variants at a cost of

\$28-\$38 million in FY1994 dollars. The Navy and Marine Corps procured 680 total aircraft, 340 B (STOVL) variants, and 340 C (CV) variants. The Marine Corps will receive 420 of the 680 JSF procurement, consisting of a combination of 340 B variants with a complement of 80 C variants. The average unit cost estimated in FY2011 was \$150 million (B variant) and \$139.5 million (C variant).¹³

The JSF's three variants incorporate a mix of components, systems and technologies with a commonality of 70 to 90 percent associated with production cost. The JSF's joint approach avoids the three parallel development programs for service-unique aircraft that would have otherwise been necessary, saving at least \$15 billion, according to former Secretary of Defense William Cohen.¹⁴ Although there has been proposed cost savings in integration of parallel development, this has also been a key contributor to the continued escalation of the production cost. Since 2010, the total cost increased by \$15 billion, with \$5 billion for additional development and \$10 billion in increased procurement cost. Compared to the projected figures from 2007, total cost has increased \$119 billion and the program has been delayed five years with initial operational capability dates uncertain due to program development.¹⁵ The cost of the JSF program increased 4.3% last year in comparison to the program baseline cost. Difficulties in concurrent development have forced the DoD to significantly reduce the quantity of procurement through 2017 in order to manage risk (see Figure 3). The Government Accountability Office March report on the JSF stated: "the long-stated intent that the JSF program would deliver an affordable, highly common fifth generation aircraft that could be acquired in large numbers could be in question."¹⁶

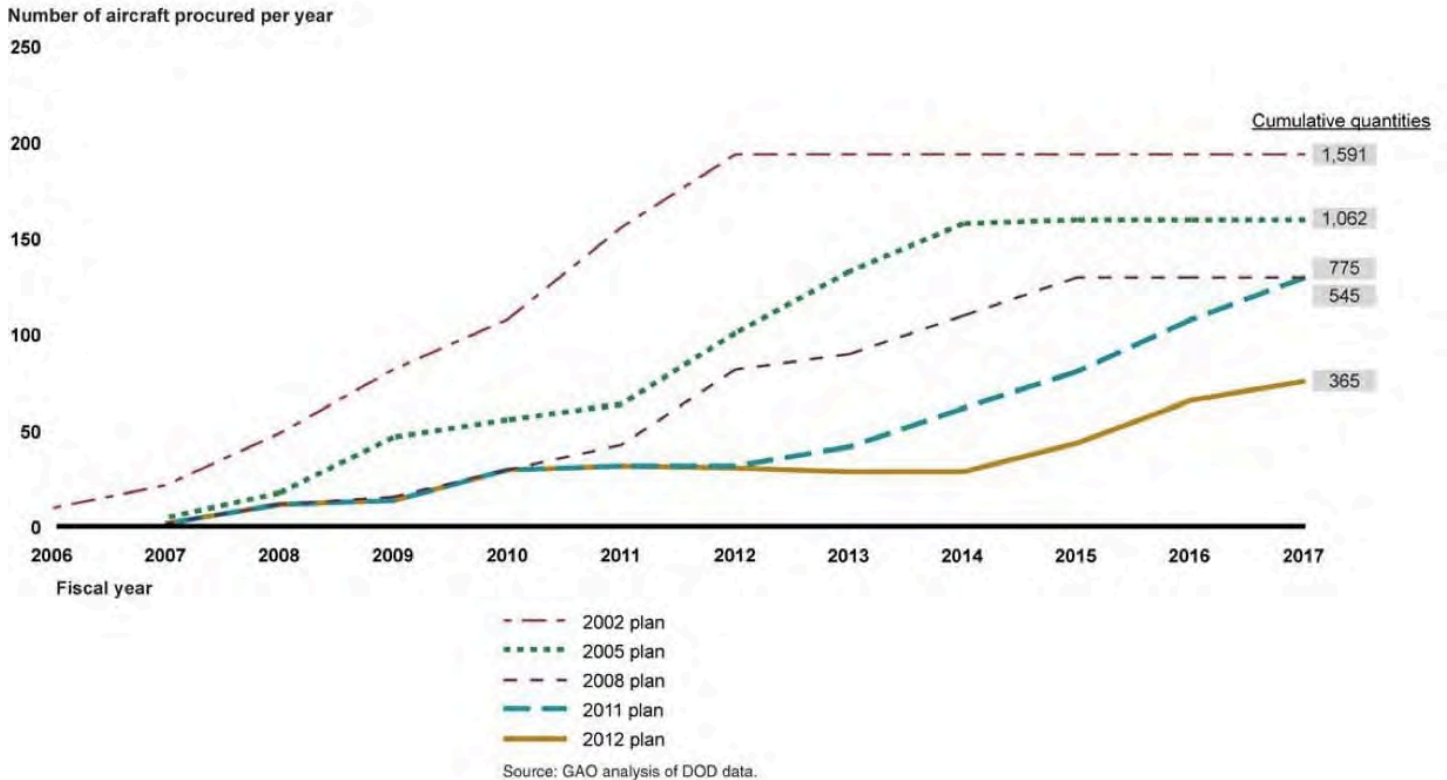


Figure 3: Changes in Procurement Plans over Time

ACE Game Changer?

There is little to dispute in regards to the capabilities the JSF brings to the battle space; but the JSF may not be the appropriate asset for the ACE in order to accomplish the primary mission of supporting the Marines on the ground. The Marine Corps needs to find a solution that satisfies the core mission of the ACE, while being cost effective. The JSF will solve the dilemma of replacing aging fixed-wing aviation assets, but the cost of the added technological advantage of a manned fighter aircraft maybe more than the Marine Corps anticipated. This would consequently degrade the rapid sortie generation capability due to sustainability problems, as revealed in the F-22 deployments. F-35 low observable (LO) technology is the main feature which separates fourth generation fighters (F/A-18 E/F) from fifth generation fighters (F-22, F-35). The F-35 and F-22 originated from the Advanced Tactical Fighter (ATF) program in 1986.

The ability to package stealth capability into a fighter aircraft was the primary focus. The product of the ATF program resulted in the F-22; the F-35 shares many commonalities in terms of stealth material and capability. In 2009, the F-22 required more than 30 hours of maintenance for every flight hour, resulting in a cost of \$44,000 per flight hour.¹⁷ The major source of the high maintenance to flight hour ratio was due to the maintenance required in sustaining the LO technology in less than ideal conditions. Therefore, using the F-22 history as a guide the assumption can be made that the technological sophistication of the JSF will be difficult to maintain due to the expeditionary operations in which the ACE routinely deploys.

The tactical fixed-wing assets primarily execute strike missions oriented toward supporting the GCE. The JSF design is oriented around fighter performance with sensor infusion wrapped in stealth. The primary attribute of low observable (LO) design is not necessary in order to accomplish most of the core missions of the ACE and may detract from the ability to generate sorties due to the maintenance required for LO technology in an expeditionary environment. The F-22 Raptor, the air superiority version of the JSF, experienced an extremely low mission capable rate of 62% in early years due to significant issues pertaining to LO technology maintenance.¹⁸ In contrast to the MAGTF concept of expeditionary airfield operations, the F-22 operates in an environment conducive to higher-level maintenance operations while the F-35B will be operating in extreme environments (expeditionary airfields or afloat) that are difficult to sustain sophisticated maintenance operations. Therefore, procuring an asset in order to acquire a capability beyond the need for the mission is fiscally inappropriate, especially in a time of significant reduced DoD budgets.

Alternative Solution

The future fiscally constrained environment requires creative solutions in order to maintain the capability desired to accomplish the mission. Senior decision makers often become fixated on spiral technological development and fail to view the requirements from the perspective of the operators. Therefore, solutions for the battlefield often look good on paper as futuristic concepts, but do not satisfy the needs of the core requirements to complete the mission in the most efficient manner. The easy answer to the fixed-wing dilemma within the MAGTF is the F-35B, but that does not make it the right answer.

The alternative to the F-35B can be achieved through readily available technology, focusing on three different areas already in current operation. This alternative to the F-35B not only can accomplish the mission of the ACE, but at a projected fraction of the cost. The three areas of emphasis are as follows: Conventional Take-off and Land (CTOL) aircraft, additional HMLA Rotary-wing assets, and Unmanned Aircraft Systems. Implementation of this alternative incurs a somewhat greater degree of risk. The planned budget cuts, however, already involve an increased level of risk. The difficulty is effectively balancing risk with capability. This alternative delivers a compromise in capability and cost in order to meet operational requirements while remaining within acceptable risk parameters. Finally, it is important to consider innovative operations outside current deployment practices.

In past operations, the United States air and naval forces have operated from sanctuaries at sea. The proliferation of anti access/area denial (A2/AD) assets has decreased the territory of uncontested employment. Long-range anti-ship missiles such as the Dong Feng 21D, which have reported ranges of 2,500 kilometers, coordinated with sophisticated integrated aircraft defense systems (IADS) create a more complex environment.¹⁹ The idea of A2/AD does not solely focus

on anti-ship ballistic missiles. A2/AD can be achieved through a variety of assets widely proliferated throughout the area in which United States forces operate. Many adversaries realize that the best way to disrupt actions near their borders is by denying access to the surrounding areas. Therefore, future strategic employment predicates a joint solution as described in concepts such as AirSea Battle. MAGTFs do not typically operate with direct support of the aircraft carrier, but in the future environment, this may become a requirement. This type of operational adjustment requires increased coordination while increasing the probability of success.

CTOL-F-35C or F/A-18E-F “Super Hornet”

Typically, MAGTF operations require the Marine Air Wing (MAW) utilize existing airfields in order to maximize resources in place. The airfields contain runways greater than 6,000 feet, which are typically large enough to allow for tactical fixed-wing aircraft operations, thus alleviating need for STOVL fixed-wing aviation. Eliminating 340 F-35B aircraft from the 3,173 JSF total procurement would increase the unit fly away cost for the other services and partner nations.²⁰ In order to avoid exacerbating the cost problem of the JSF, the Marine Corps could purchase the F-35C. The F-35C provides increased capability in all performance aspects compared to the F-35B: range, endurance, and weapons carriage capability. Consideration should be given to adjusting the Marine procurement mix of JSF (340 F-35B, 80 F-35C). Instead of procuring 340 F-35B, STOVL aircraft should be limited to a one-to-one replacement with the AV-8B fleet. The USMC AV-8B fleet consists of seven squadrons with 14 aircraft, and one training squadron of 28 aircraft, totaling approximately 126 aircraft.²¹ Therefore, replacing the 126 AV-8B with F-35B, would allow the Marine Corps to procure 294 F-35C. This would provide enough STOVL capability to satisfy the Expeditionary Strike Group (ESG) requirement. This would also allow the Marine Corps to enhance the Tactical Aviation Integration (TAI)

agreement with the Navy. The Marine Corps plans to procure only 80 F-35C to integrate into Navy carrier air-wings. Navy/Marine Corps interoperability improves by increasing the F-35C quantity and decreasing the F-35B quantity. This scenario creates the option of increasing the carrier air wings from 44 to 60 fixed-wing aircraft, thus increasing the maritime power projection with increased Marine assets. Another idea could be the creation of an additional carrier air wing to increase the current number from 10 to 11. There are no plans to integrate the F-35B onto aircraft carriers due to the STOVL requirements conflicting with cyclic operations of conventional aircraft. This results in a possible decrease in the TAI interoperability between the Navy and Marine Corps.

The environment in which the MAGTF deploys, low observable entry by tactical fixed-wing assets may not be required. In recent operations, the ACE has operated independently in environments that are predominantly low threat in the Air-to-Air (A/A) and Surface-to-Air (S/A) environment rendering the requirement for stealth strike fighter questionable at best. Therefore, current aircraft currently in production can satisfy the requirements for the mission of the ACE. The most likely candidate would be the upgraded F/A-18E or F/A-18F Super Hornet. The Super Hornet production line is still producing aircraft for the Navy at a unit fly-away cost of \$66.9 million. This aircraft has been operationally tested and is a familiar model of aircraft to the Marine Corps ([see Appendix E](#)). The F/A-18E or F/A-18F provides an extremely effective Close Air Support (CAS) platform. The avionics systems incorporated in the aircraft deliver state of the art situational awareness to the aircrew. The Super Hornet is equipped with the APG-79 Active Electronically Scanned Array (AESA) Radar which is a leap tactical radar technology. Particularly in Air-to-Ground scenarios, the APG-79 has the ability to provide weapons quality coordinates on targets of opportunity (F-35 utilizes the APG-81 AESA radar). In addition, the

Super Hornet is equipped with the Joint Helmet-Mounted Cueing System (JHMCS). In an air-to-ground role, the JHMCS is used in conjunction with targeting sensors (radar, FLIR, etc.) and "smart weapons" to accurately and precisely attack surface targets perfect for CAS support mission to accurately identify and attack targets in the visual arena. In all roles, the JHMCS provides the pilot with aircraft performance, targeting, weaponry and threat warning information, regardless of where the pilot is looking, significantly enhancing pilot situation awareness throughout the mission. In a dual-seat aircraft, each crewmember can wear a JHMCS helmet, perform operations independent of each other, and have continuous awareness of where the other crewmember is looking. The Super Hornet also employs the most extensive radar cross section reduction measures of any contemporary aircraft excluding the F-22 and F-35. The Super Hornet in comparison to the JSF provides upgraded fourth generation capability, which makes the aircraft an attractive alternative to the JSF. Combine the capability upgrades with a 90% parts commonality with legacy F/A-18, and the Super Hornet becomes a viable option. The operational and logistical upgrades provided by the Super Hornet demonstrate significant justification for the price tag of \$66.9 million vice \$150 million (see Appendix D). Thus, the F/A-18E or F/A-18F provides an extremely attractive alternative to the F-35B. This is a prime example of an identified risk that could be mitigated by delaying response times for the MAGTF or accepting risk in theater operations until tactical fixed-wing assets arrive. These tactical fixed-wing coverage gaps can be cover by coordinating carrier air wing support from aircraft carriers until Marine Corps fixed-wing assets arrived similar to the battle of Guadalcanal.

Rotary-Wing

The early missions of Marine Corps aviation began with defense of advance naval bases and eventually evolved into Close Air Support. The coming of age in Marine aviation was the

Battle of Guadalcanal, in which VMF-223 from Marine Aircraft Group (MAG) 23 led by Maj. John L. Smith and other squadrons managed to help turn the tide in Operation Watchtower.²² The first Marine Corps helicopter squadron to participate in combat was Marine Observation Squadron 6 in the Battle of Pusan Perimeter, flying HO3S-1 helicopters; executing artillery spotting and aerial reconnaissance.²³ The rotor-wing assets of the present day ACE consisting of AH-1, UH-1, MV-22, CH-53, and CH-46s demonstrate highly flexible and capable force able to execute four of the five kinetic missions of the ACE. The advances in attack helicopter technology have established a highly capable platform in terms of aerial support for ground combat troops. In addition to the success of AH-1W and the UH-1N, the Marine Corps launched the H-1 upgrade program. This program seeks to upgrade 280 UH-1Ns and AH-1Ws to UH1Ys and AH-1Zs, effectively creating 280 new airframes remanufactured with the latest technology ([see Appendix F](#)). Not only does the H-1 upgrade implement new technology into the rotary fleet, but it creates a savings in maintenance training, ground handling, support equipment, and spare parts inventories which add up to billions of dollars in cost savings over the life of the program due to the commonality of parts amongst the two platforms.²⁴ Along with significant cost savings, the H-1 upgrade dramatically increases the range, speed, payload, and lethality of the rotary fleet. The upgrades of the H-1 program result in an AH-1 and UH-1 capable of significantly increased performance (see Appendix E).

In addition to increased performance, development of helicopter attack systems such as the Advanced Precision-Kill Weapon System (APKWS) has placed the rotary wing on the leading edge of the battlefield.²⁵ APKWS attaches to current unguided rocket munitions by using a compatible laser seeker kit, providing an excellent, low cost, mid-range weapon. This system is similar to the laser-guided bomb (LGB) upgrade to general-purpose bombs (i.e. MK-80 series

munitions) for fixed wing aircraft developed in the early 1960s. The APKWS system increases the lethality and precision of attack helicopters while enabling a smaller collateral damage footprint. Although the APKWS is not the panacea in the CAS environment, it does represent a developing trend towards a more effective CAS asset in a limited threat environment. The primary threats to helicopter assets in the CAS environment include: antiaircraft artillery (AAA), rocket propelled grenades (RPGs), and surface-to-air missiles (SAM). These threats are mitigated through detection, tactical aircraft maneuvers, and stand-off weapons. One of the present limiting factors in the AH-1 CAS employment is the lack of stand-off capability. Currently the primary stand-off weapon is the AGM-114 Hellfire ([see Appendix G](#)). The Hellfire provides a maximum operational range of approximately of 8 kilometers. The future development and introduction of systems such as AGM-169 Joint Common Missile (JCM) will double the stand-off range from 8 km to 16 km.²⁶ Although helicopter assets provide effective capability in the CAS environment, it is unable to deliver the heavy ordnance (500, 1,000, and 2,000 lbs) of the fixed-wing element. This increased weapons performance coupled with the enhanced detection and maneuverability of the AH-1Z creates an all rotor-wing ACE capable of supporting the GCE in a limited CAS environment.

Increases in operational coordination between the carrier strike group (CSG) and the expeditionary strike group (ESG) can address the limitations of an all rotor-wing ACE. The anticipated environment described by the current AirSea Battle doctrine may require change in future operational activities. As uncontested territory at sea decreases due to A2/AD systems, freedom of navigation at sea requires an emphasis on coordinated operations. Operations of CSGs with ESGs in high threat environments such as China and Iran, increase survivability and power projection. This does not tether the amphibious elements to the carrier strike groups in

day-to-day operations. This does require maintaining a familiar practice of coordinated operations between the CSG and the ESG. In Talisman Saber 2007, the USS Nimitz and the USS Essex initiated an exercise in Expeditionary Strike Force (ESF) operations. This exercise demonstrated the unique capability of the CSG to support the ESG through mission such as air defense, anti-submarine warfare, and CAS.²⁷ The CSGs rapid response time enables the carrier air wing to provide fixed-wing aviation support to the ESG within 24 hours or less, anywhere in the world. Every scenario will be different based on the threat environment. Some situation may require a fixed-wing element and others will not.

Coordinating future operations of CSGs and ESGs, when required, will ensure sufficient coverage for the GCE.

Unmanned Aircraft Systems (UAS)

The evolution of Unmanned Aircraft Systems has taken advanced surveillance platforms to a priority combat asset for the Combatant Commanders. UAS production and procurement, as demonstrated by the latest defense budget, is one of the only areas increasing in funding. In 2005, UAS compiled over 100,000 flight hours in support of Operations ENDURING FREEDOM and IRAQI FREEDOM. Rapid advances in technology enable the merging of capability onto smaller airframes, which has spurred the large increase of UAS technology on the battlefield. UAS have historically filled a role of sustained intelligence, surveillance, and reconnaissance (ISR), but recent weaponization programs have expanded the asset into the mission sets of electronic attack (EA), strike missions, and suppression and/or destruction of enemy air defense (SEAD/DEAD). Combine this increased capability with endurance unmatched by any manned fighter aircraft, and the UAS is a combat capability worth significant investment. The Marine Corps' tactical fixed-wing dilemma presents a revolutionary opportunity to lead the

Armed Services into the era of UAS dominance. The Marine Corps currently deploys UAS from every level ranging from Group 1 (small) to Group-4 (large) ([see Appendix H](#)). Battalion level units utilize the smaller systems (Group 1), while VMU squadrons employ the larger and more complex systems (Group 3 and 4).²⁸ According to the FY2011 Marine Aviation Plan, expansion of UAS operations of more capable assets is within the framework of the UAS plan. The Marine Corps presently operates three UAS squadrons: VMU-1, VMU-2, and VMU-3 flying RQ-7 Shadows and Scan Eagles. The Marine Corps is currently testing a contract cargo UAS being fielded for user assessment. This cargo UAS provides logistical support to company-sized forces in the most forward positions in a combat zone.²⁹ The current programs in the Marine Corps UAS family demonstrate not only a significant contribution to the mission in the field, but a demand for the system, and more importantly a willingness to implement these systems.

The procurement of a complete UAS system for two RQ-7 Shadows including the command suite, costs approximately \$36 million, however an individual RQ-7 only costs \$275,000. In order for the Marine Corps to abandon the tactical fixed-wing aviation component of the ACE, UAS assets would need to be upgraded to larger more capable units such as the MQ-9 Reaper. MQ-9 Reapers would provide the ACE with highly capable UAS able to conduct ISR, CAS, Combat search and rescue (CSAR), precision strike, friend-to-friend laser designations, convoy/raid over-watch, route clearance, target development, and terminal air guidance. The Reaper armament consists of AGM-114 Hellfire missiles, GBU-12 Paveway II, and GBU-38 Joint Direct Attack Munitions. Four aircraft with sensors cost \$60.3 million FY2012.³⁰ For the cost of one JSF F-35B (\$151.8 million FY2012), approximately 11 MQ-9 Reapers can be acquired. The transformation of manned squadrons has already begun in the United Kingdom: on 16 May, 2011 the Ministry of Defense (MOD) formally announced the transition of one

squadron of GR4 Tornados to a MQ-9 Reaper squadron.³¹ According to the former Chairman, Joint Chiefs of Staff, Admiral Michael G Mullen, the JSF will be the last manned fighter aircraft.³² The dramatic rise in cost suggested by the F-22 and F-35 coincides with the rapid development of UAS technology and capability.³³

Therefore, instead of the Marine Corps investing in technology that could become obsolete, serious discussions need to commence about complementary Unmanned Aircraft Systems phasing into missions of the tactical fixed-wing element of the ACE.

Conclusion

The Department of Defense budget reduction of \$487 billion over the next 10 years requires serious changes in service structure. As a result, each service, including the Marine Corps, must assess its future role and mission within the joint environment in order to assure appropriate capability. The Commandant's Planning Guidance specifies the mission of the modern day Marine Corps to include: expeditionary force in readiness and applicable across the ROMO (range of military operations), etc. One of the most important elements of the Commandant's goals is future force reshaping and asset procurement while maintaining capability with decreasing capacity.

The tactical fixed-wing portion of the ACE represents an aspect of the MAGTF that has become extremely expensive to maintain. In particular, the JSF F-35B is quickly becoming a cost prohibitive option even before IOC. The F-35B's cost and questionable sustainability is antithetical to the ideal of an affordable and flexible MAGTF capable of executing the future conflicts envisioned for the Marine Corps. In the era of increased A2/AD, joint operational execution underpins the solution for access to these complex environments. Consequently, combining operations of the MAGTF and fixed-wing assets from the aircraft carrier or the Air

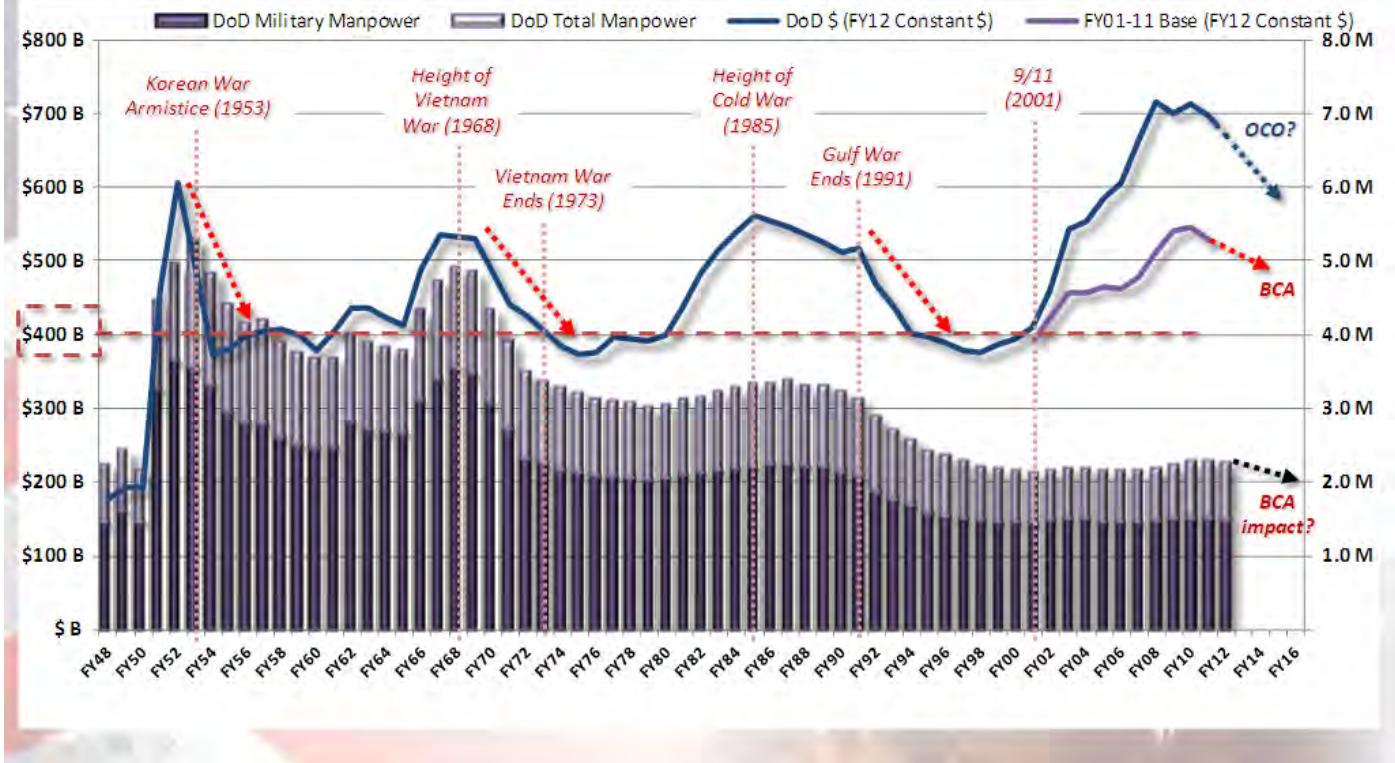
Force generate the overmatch necessary to complete the mission. Although this is not common practice today, adjustments in execution will generate positive results. Implementation of the alternative plan mentioned above has the potential to produce a MAGTF that reflects the organization described in the Commandant's Planning Guidance: a capable middleweight force with an aviation combat element that is nested within the future budget environment.

Appendix A: Defense Budget Over Time



The Defense Budget Over Time

- Discretionary spending is ~35% of total federal budget – Defense budget is ~50% of discretionary spending
- Increasing emphasis on reducing spending/deficit – *Congress and the Administration*
- Historically, funding levels have decreased as military demand decreases



Source: LTG William J. Troy, Director of the Army Staff, presentation 6 MAR 2012 Breckenridge Hall

Appendix B: MAGTF Capability

MAGTF Capability (MCDP 1-0, Marine Corps Operations)

- Move forces into crisis areas without revealing their exact destinations or intentions.
- Provide continuous presence in international waters.
- Provide immediate national response in support of humanitarian and natural disaster relief operations.
- Provide credible combat power in a non-provocative posture, just over the horizon of a potential adversary, for rapid employment as the initial response to a crisis.
- Support diplomatic processes for peaceful crisis resolution before employing immediately responsive combat forces.
- Project measured degrees of combat power ashore, day or night, and under adverse weather conditions, if required.
- Introduce additional forces sequentially into a theater of operations.
- Operate independent of established airfields, basing agreements, and over flight rights.
- Conduct operations ashore using organic combat service support brought into the AO.
- Enable the introduction of follow-on forces by securing staging areas ashore.
- Operate in rural and urban environments.
- Operate under nuclear, biological, and chemical warfare conditions.
- Withdraw rapidly at the conclusion of operations.
- Participate fully in the joint planning process and successfully integrate MAGTF operations with those of the joint force.

Appendix C: ACE Missions

Aviation Combat Element Missions

Offensive Air Support - air operations conducted against enemy installations, facilities, and personnel in order to directly assist in the attainment of MAGTF objectives by destroying enemy resources or isolating enemy military forces

Close Air Support (CAS) - air action performed by fixed-wing and rotary-wing aircraft against hostile targets that are in close proximity to friendly forces.

Deep Air Support (DAS) - air action against enemy targets at such a distance from friendly forces that detailed integration of each mission with fire and movement of friendly forces is not required.

Capable Aviation Assets: VMFA, VMA, HMLA, VMU

Anti-Air Warfare - actions used to destroy or reduce the enemy air and missile threat to an acceptable level.

Offensive Anti-air Warfare (OAAW) - operations conducted against enemy air assets and air defense systems before they can be launched or assume an attacking role

Air Defense – All defensive measures designed to destroy attacking enemy aircraft or missiles in the Earth's atmosphere or to nullify or reduce the effectiveness of an enemy attack

Capable Aviation Assets: VMFA, VMFA(AW), VMA, HMLA, LAAD

Assault Support – utilization of aircraft to provide tactical mobility and logistic support for the movement of high priority personnel and cargo within the immediate area of operations (or the evacuation of personnel and cargo)

Combat Assault Transport - used to deploy forces efficiently in offensive maneuver warfare, bypass obstacles, or quickly redeploy forces

Air Delivery - Air delivery is the transportation of equipment and supplies to forward operating bases (FOB) or remote areas

Aerial Refueling - Aerial refueling allows aircraft, both fixed- and rotary-wing, to

conduct flight-ferrying operations, extend time on station, and extend mission range
Air Evacuation - the transportation of personnel and equipment from FOBs or remote areas

Tactical Recovery of Aircraft and Personnel (TRAP) - performed by an assigned and briefed rotary-wing aircrew for the specific purpose of the recovery of personnel, equipment, and/or aircraft

Air Logistical Support – delivery of troops, equipment, and supplies to areas beyond helicopter range and lift capability or when surface transportation is slow or unavailable

Battlefield Illumination – delivery of illumination to the battlefield by both fixed-wing and rotary-wing aircraft

Capable Aviation Assets: HMMH, HMM, HMLA

Air Reconnaissance - employs visual observation and/or sensors in aerial vehicles to acquire intelligence information

Visual Reconnaissance – may be conducted by any airborne platform, consisting of an observer or pilot visually searching a route, point, or area

Multisensor Imagery Reconnaissance - used to detect and pinpoint the location of enemy installations, facilities, and concentrations of forces utilizing photograph and radar imagery from the advanced tactical aerial reconnaissance system (ATARS), and infrared imagery

Electronic Reconnaissance - used to detect, locate, identify, and evaluate enemy electromagnetic radiation

Capable Aviation Assets: VMU

Electronic Warfare – military action involving the use of electromagnetic and directed energy to control the electromagnetic spectrum or to attack the enemy

Electronic Attack - EW that involves the use of electromagnetic energy, directed energy, or anti-radiation weapons to attack personnel, facilities, or equipment with the intent of degrading, neutralizing, or destroying enemy combat capability

Electronic protection - the actions taken to protect personnel, facilities, and equipment from the effects of friendly or enemy employment of EW that degrades, neutralize, or destroy friendly combat capability

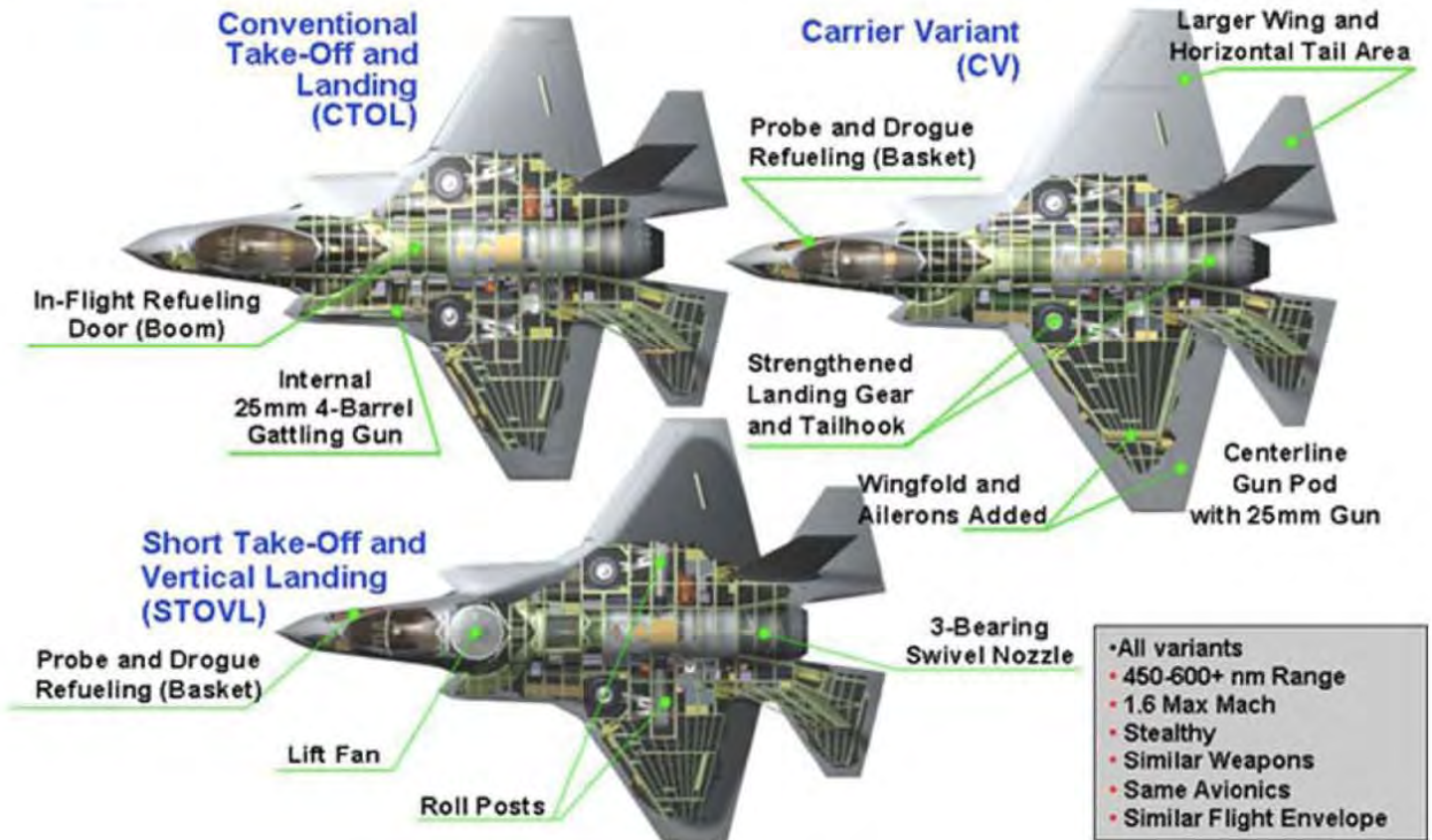
Capable Aviation Assets: VMA

Appendix D: JSF Family of Aircraft



JSF Family Of Aircraft

One Program -- Three Variants
Meeting Service and International Needs



Appendix E: F/A-18 Super vs. Legacy Comparison

Side-by-side comparison¹ of the Super Hornet to the Legacy Hornet

Performance

- 20 % increase in overall size
- 33 % increase in internal fuel capacity
- 33% increase weapons carriage capability
- 35% increased thrust
- 41% increase in range
- 50% increase in endurance
- Significant radar signature reduction measures
- Organic aerial refueling capability

Avionics

- APG-79 Active Electronically Scanned Array (AESA) Radar
 - Enables simultaneous A/A and A/G attacks, providing higher resolution than previous Legacy Hornet radar systems (APG 65, 73)
- Joint Helmet Mounted Cueing System (JHMCS)
 - JHMCS integrates weapons system and navigation information into the helmet visor display.
- Multifunctional Information Distribution System-Joint Tactical Radio System (MIDS-JTRS)
- Secure digital communication information sharing network that allows integrates

¹ Side-by-side comparison is not demonstrated with an EA-6B or AV-8B as the Legacy F/A-18 is regarded to be the most capable of the three aircraft in the Marine inventory.

communications between fighter-to-fighter and fighter-to-ground elements

Source: "F/A-18E/F Super Hornet, United States of America," *naval-technology.com*, <http://www.naval-technology.com/projects/fa18-super-hornet/> (accessed 21 January, 2012).

Appendix F: H-1 Upgrades

AH-1W vs. AH-1Z

Marine Aviation

	AH-1W	AH-1Z	Improvement
Max. gross weight, lb.	14,750	18,500	25%
Max. internal fuel, lb.	2,100	2,768	32%
Empty Weight	10,200	11,828	
HOGUE useful load, SL/hot, lb.	3,986	5,558	39%
* Cruise speed, 3k ft/hot, ktas	131	137	5%
* Mission radius with attack payload, nm	58	139	140%
*Maneuverability (g's)	+0.5 to +2.4	-0.5 to +2.5	



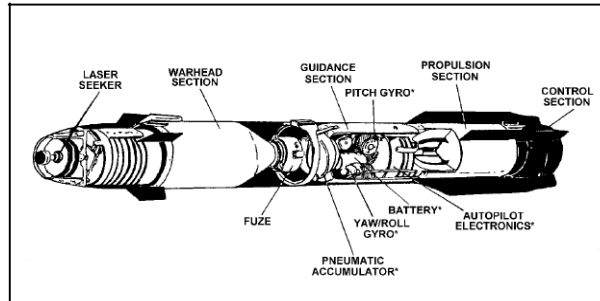
UH-1Y vs. UH-1N

Marine Aviation



	UH-1N	UH-1Y	Improvement
Max. gross weight, lb.	10,500	18,500	76%
Max. internal fuel, lb.	1,360	2,584	90%
Empty Weight	7,100	11,838	
HOGE useful load, SL/hot, lb.	3,532	5,930	68%
*Utility cruise speed, 3k ft/hot, ktas	107	153	43%
*Mission radius with eight fully loaded combat troops, nm	0	129	
*Maneuverability [g's]	+0.5 to +2.27	-0.5 to +2.3	

Appendix G: AGM-114 Hellfire

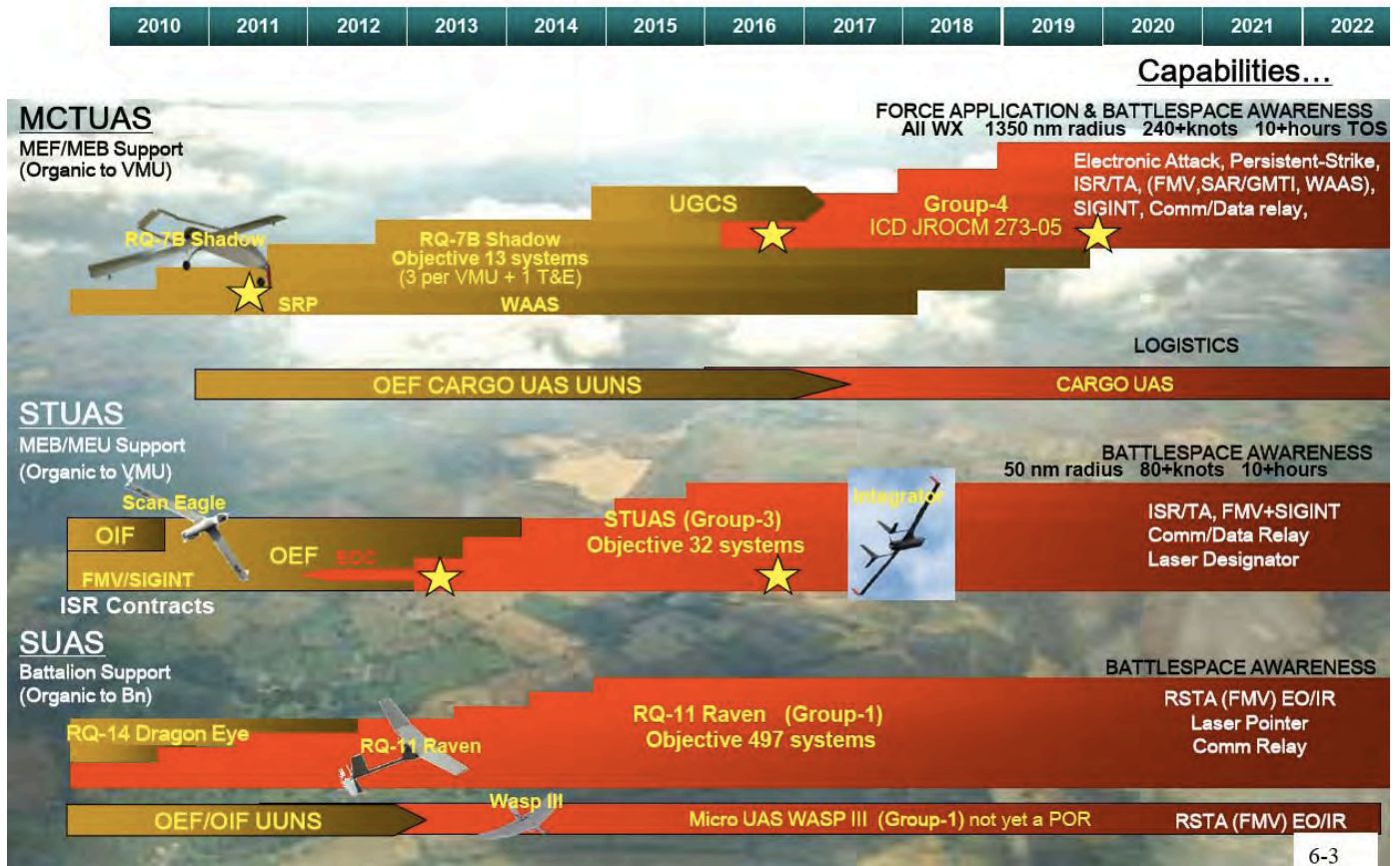


Weight (each missile):	100.9 lbs (108 lbs - L Model)
Length:	64 inches (69 in. - L Model)
Diameter:	7 inches
Wingspan:	12.8 inches
Max. Velocity:	950 mph - 475m/sec - 1393 fps (1.4 mach)
Velocity required to Arm:	10 Gs (normally achieved 150-300m in front of the aircraft)
Warhead:	Copper-lined conical shape charge, High Explosive Anti-Tank (HEAT) - explosive force equivalent to 35 mach
Sub-components:	5 sections - Seeker; Warhead; Guidance; Propulsion; Control
Launch Motor:	Solid Fuel (2-3 seconds to motor burnout after launch)
Effective Range:	500m minimum range; 8000m maximum effective range
Missile Battery Life:	46 seconds +/- 2 seconds
Maximum Rate of Fire:	1 missile every two seconds
Number of models:	6; AGM-114A/B/C/F/K/L
Manufacturer(s):	Rockwell International Systems Division and Martin Marietta Inc.

Table 1. Missile Specifications

Appendix H: USMC UAS

USMC UAS Family of Systems Road Map



Source: FY2011 Marine Aviation Plan

ENDNOTES

¹ *Sustaining U.S. Global Leadership: Priorities for 21st Century Defense*

² Andrew Feickert and Stephen Daggett, *A Historical Perspective on “Hollow Forces”*. CRS Report for Congress R42334. Washington, DC: Congressional Research Service, January 31, 2012

³ Congressional Budget Office, *Reducing the Deficit: Spending and Revenue Options* (Washington, DC: Congressional Budget Office, 2011), <http://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/120xx/doc12085/03-10-reducingthedeficit.pdf>.

⁴ Headquarters U.S. Marine Corps. *Marine Corps Operations*. MCDP 1-0 (Washington, DC: Headquarters U.S. Marine Corps, September 27 2001), 2-2.

⁵ Headquarters U.S. Marine Corps. *Aviation Operations*. MCWP 3-2 (Washington, DC: Headquarters U.S. Marine Corps, May 9 2000), 1-1.

⁶ Fiscal Year (FY) 2013 President’s Budget Submission: Navy Justification Book Volume 1 Aircraft Procurement, Navy Budget Activities 1-4, p. 1-15.

⁷ FY2011 Marine Aviation Plan, Head Quarters United States Marine Corps (Deputy Commandant of Aviation), 16 September 2010, 3-3.

⁸ McMichael, William H. “The Plan to keep F/A-18s flying”, Navy Times, 28 February, 2011. <http://www.navytimes.com/news/2011/02/navy-inspection-repair-programs-for-hornet-fleet-022811w/>

⁹ FY2011 Marine Aviation Plan, Head Quarters United States Marine Corps (Deputy Commandant of Aviation), 16 September 2010, 3-3.

¹⁰ Ronald O’Rourke, Navy-Marine Corps Strike-Fighter Shortfall: Background and Options for Congress, CRS Report for Congress RS22875 (Washington, DC: Congressional Research Service, May 12, 2008), CRS-2 & 3, <http://www.fas.org/sgp/crs/weapons/RS22875.pdf>

¹¹ Deputy Secretary of Defense William Lynn III, Speech (American Society of Military comptrollers, Washington, D.C., 17 March 2011). <http://www.defense.gov/speeches/speech.aspx?speechid=1552>

¹² Christopher Bolkcom, *Joint Strike Fighter (JSF) Program: Background, Status, and Issues*, CRS Report for Congress RL30563 (Washington, DC: Congressional Research Service, June 16 2003), 2, <http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA472773>

¹³ Nick Schwellenbach, “JSF FAR More Expensive Than Aircraft They’re Replacing,” *Project On Government Oversight*, February 15, 2011, <http://pogoblog.typepad.com/pogo/2011/02/jsf-likely-far-more-expensive-than-aircraft-theyre-replacing.html>.

¹⁴ Letter from Secretary of Defense William S. Cohen to Rep. Jerry Lewis, *Inside the Airforce*, June 22, 2000.

¹⁵ Government Accountability Office, *JOINT STRIKE FIGHTER Restructuring Added Resources and Reduced Risk, but Concurrency Is Still a Major Concern* (Washington, DC: Government Accountability Office, 20 March 2012), 4. <http://www.gao.gov/assets/590/589454.pdf>

¹⁶ Government Accountability Office, *JOINT STRIKE FIGHTER Restructuring Added Resources and Reduced Risk, but Concurrency Is Still a Major Concern* (Washington, DC: Government Accountability Office, 20 March 2012), 6. <http://www.gao.gov/assets/590/589454.pdf>

¹⁷ R. Jeffrey Smith, “High-Priced F-22 Fighter Has Major Shortcomings”, Washington Post, July 10, 2009, <http://www.washingtonpost.com/wp-dyn/content/article/2009/07/09/AR2009070903020.html>

¹⁸ Jim Wolf, “U.S. fighter plane needs major upgrades-arms buyer,” Reuters, November 20, 2008, <http://www.reuters.com/article/2008/11/20/usa-fighter-lockheed-idUSN2035135720081120?sp=true>.

¹⁹ Richard Fisher Jr., “New Chinese Missiles Target the Greater Asian Region, July 24, 2007, http://www.strategycenter.net/research/pubID.165/pub_detail.asp.

²⁰ Estimated JSF Air Vehicle Procurement Quantities, Updated April 2010, 88. http://www.jsf.mil/downloads/documents/JSF_PSFDF_MOU_-_Update_4_2010.PDF

²¹ FY2011 Marine Aviation Plan, Head Quarters United States Marine Corps (Deputy Commandant of Aviation), 16 September 2010, 3-6.

²² Richard G. Hubler and John A. Dechant, *Flying Leathernecks - The Complete Record of Marine Corps Aviation in Action 1941 – 1944* (Garden City, New York: Doubleday, Doran & Co., Inc.), p.40.

²³ James A. Field Jr., *History of United States Naval Operations: Korea* (Washington, DC: Naval Historic Center, 1962), Chapter 5, Part 6. <http://www.history.navy.mil/books/field/ch5f.htm>.

²⁴ Navy Training System Plan For The United States Marine Corps, H-1 UPGRADES PROGRAM, N88-NTSP-A-50-9602/A December 1997.

²⁵ Defense Industry Daily, “APKWS II: Laser-Guided Hydra Rockets in Production At Last”. [defenseindustrydaily.com](http://www.defenseindustrydaily.com/apkws-ii-hellfire-jr-hydra-rockets-enter-sdd-phase-02193/), February 12, 2012, <http://www.defenseindustrydaily.com/apkws-ii-hellfire-jr-hydra-rockets-enter-sdd-phase-02193/> (Accessed March 15, 2012)

²⁶ Lockheed Martin, Joint Common Missile, <http://defense-update.com/products/j/jcm.htm>

²⁷ Chief Mass Communication Specialist (SW/AW) Ty Swartz and Mass Communication Specialist 2nd Class Alexander Ameen, “Nimitz and Essex Strike Groups Complete Expeditionary Strike Force training,” *Navy.mil*, March 17, 2008, http://www.navy.mil/search/display.asp?story_id=35791 (accessed April 25, 2012).

²⁸ FY2011 Marine Aviation Plan, Head Quarters United States Marine Corps (Deputy Commandant of Aviation), 16 September 2010, 6-2.

²⁹ FY2011 Marine Aviation Plan, Head Quarters United States Marine Corps (Deputy Commandant of Aviation), 16 September 2010, 6-2.

³⁰ U.S. Air Force, MQ-9 Reaper Factsheet, <http://www.af.mil/information/factsheets/factsheet.asp?fsID=6405>. (Accessed January 22, 2012)

³¹ Defense Industry Daily, “Britain’s RAF Requests 10 MQ-9 Reapers for over \$1 B”, [defenseindustrydaily.com](http://www.defenseindustrydaily.com/britain-requests-10-mq-9-reapers-for-over-1b-04536/#uk-uavs), December 12, 2010, <http://www.defenseindustrydaily.com/britain-requests-10-mq-9-reapers-for-over-1b-04536/#uk-uavs>. (Accessed January 22, 2012)

³² Michael W. Isherwood, Unmanned Systems and the Joint Team, NDU Press, <http://www.ndu.edu/press/unmanned-systems.html>.

³³ The Economist, “The last manned fighter”, July 2011, <http://www.economist.com/node/18958487>.

BIBLIOGRAPHY

BOOKS

Field Jr., James A. *History of United States Naval Operations: Korea*. Washington, DC: Naval Historic Center, 1962 <http://www.history.navy.mil/books/field/ch5f.htm>.

Hubler, Richard G., and John A. Dechant. *Flying Leathernecks - The Complete Record of Marine Corps Aviation in Action 1941 – 1944*. Garden City, New York: Doubleday, Doran & Co., Inc., 1944.

Wheeler, Winslow, ed. *The Pentagon Labyrinth*. Washington, D.C.:Center for Defense Information, 2011.

DOCTRINAL PUBLICATIONS

Headquarters U.S. Marine Corps. *Marine Corps Operations*. MCDP 1-0. Washington, DC: Headquarters U.S. Marine Corps, September 27 2001, 2-2.

Headquarters U.S. Marine Corps. *Aviation Operations*. MCWP 3-2. Washington, DC: Headquarters U.S. Marine Corps, May 9 2000, 1-1.

Headquarters U.S. Marine Corps. *Expeditionary Operations*. MCDP 3. Washington, DC: Headquarters U.S. Marine Corps, April 16 1998.

NEWS ARTICLES

Defense Industry Daily, “Britain’s RAF Requests 10 MQ-9 Reapers for over \$1 B”, [defenseindustrydaily.com](http://www.defenseindustrydaily.com/britain-requests-10-mq-9-reapers-for-over-1b-04536/#uk-uavs), December 12, 2010, <http://www.defenseindustrydaily.com/britain-requests-10-mq-9-reapers-for-over-1b-04536/#uk-uavs>. (accessed January 22, 2012)

The Economist, “The last manned fighter”, July 2011, <http://www.economist.com/node/18958487>.

Hough, Michael. “State of Marine Aviation” *Marine Corps Gazette*, May, 2005.

Munoz, Carlo. “Marines Push F-18s To the Limit; When Will They Begin to Fail?”, Aol Defense25 August, 2011 <http://defense.aol.com/2011/08/25/marines-pushing-f-18s-to-the-limit-when-will-they-begin-to-fail/>.

McMichael, William H. “The Plan to keep F/A-18s flying”, Navy Times, 28 February, 2011. <http://www.navytimes.com/news/2011/02/navy-inspection-repair-programs-for-hornet-fleet-0228111w/>.

-
- Martin-Baker. "A History of the Joint Strike Fighter Programme." April 2011.
http://www.martin-baker.co.uk/getdoc/d25952ab-5881-4999-8593-6f7f196c8770/a_history_of_the_joint_strike_fighter_programme.aspx.
- Munson, Peter J. "Middleweight Force? Relevant Force?" *Marine Corps Gazette*, January 11, 2012. <http://mcgazette.blogspot.com/2012/01/middleweight-force-relevant-force.html>.
- Panetta: Coming Budget Cuts Demand Careful Balance, American Forces Press Service Parrish, Karen <http://www.defense.gov/news/newsarticle.aspx?id=66698>.
- Schwellenbach, Nick. "JSF FAR More Expensive Than Aircraft They're Replacing." *Project On Government Oversight*, February 15, 2011.
<http://pogoblog.typepad.com/pogo/2011/02/jsf-likely-far-more-expensive-than-aircraft-theyre-replacing.html>.
- Swartz, Ty Chief Mass Communication Specialist (SW/AW) and Mass Communication Specialist 2nd Class Alexander Ameen. "Nimitz and Essex Strike Groups Complete Expeditionary Strike Force training." *Navy.mil*, March 17, 2008.
http://www.navy.mil/search/display.asp?story_id=35791 (accessed April 25, 2012).
- Tiron, Roxana, "Fast Jets Not Ideal Choice for Close Air Support",
Nationaldefensemagazine.org, April 2004,
http://www.nationaldefensemagazine.org/archive/2004/April/Pages/Fast_Jets3594.aspx.
- Wolf, Jim. "U.S. fighter plane needs major upgrades-arms buyer." Reuters, November 20, 2008.
<http://www.reuters.com/article/2008/11/20/usa-fighter-lockheed-idUSN2035135720081120?sp=true>.

GOVERNMENT REPORTS

- Bolkcom, Christopher. *Joint Strike Fighter (JSF) Program: Background, Status, and Issues*. CRS Report for Congress RL30563. Washington, DC: Congressional Research Service, June 16, 2003. <http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA472773>
- Congressional Budget Office, *The Budget and Economic Outlook: Fiscal Years 2011 to 2021* (Washington, D .C .: January 2011), p.1
- Congressional Budget Office, *Reducing the Deficit: Spending and Revenue Options*. Washington, DC: Congressional Budget Office, 2011.
<http://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/120xx/doc12085/03-10-reducingthedeficit.pdf>

Department of The Navy Fiscal Year (FY) 2012 Budget Estimates, Aircraft Procurement Vol. I, BA 1-4, February 2011.

Government Accountability Office. *JOINT STRIKE FIGHTER Restructuring Added Resources and Reduced Risk, but Concurrency Is Still a Major Concern*. Washington, DC: Government Accountability Office, 20 March 2012.
<http://www.gao.gov/assets/590/589454.pdf>

Government Accountability Office. *Operation Desert Storm: Evaluation of the Air Campaign*. Washington, DC: Government Accountability Office, 1997.
http://www.au.af.mil/au/awc/awcgate/gao/nsiad97134/app_04.htm.

Headquarters of the Marine Corps, Deputy Commandant of Aviation. FY2011 Marine Aviation Plan, 16 September 2010.

INDEPENDENT REPORTS

Naval-technology.com, "F/A-18E/F Super Hornet, United States of America," <http://www.naval-technology.com/projects/fa18-super-hornet/>

Tate, Maj Frank W. "Army Attack Aviation Returning to the Close Fight: Impact of the MOUT Environment." Master's Thesis, School of Advanced Military Studies, 2001.
<http://www.combatreform.org/majortatesthesis.htm>.

SPEECH

Deputy Secretary of Defense William Lynn III, Speech, American Society of Military comptrollers, Washington, D.C., 17 March 2011.
<http://www.defense.gov/speeches/speech.aspx?speechid=1552>

INTERVIEWS

Laura Geis, Center of Naval Analysis (CNA) Research Scientist, Office of Tactical Analysis, Marine Corps Aviation, telephone conversation.

CAPT Michael Kelly, USN, Commander Naval Air Forces N42, email and telephone conversation, April 15-17, 2012.

CAPT Jan Van Tol, USN Ret., Senior fellow at Center for Strategic and Budgetary Assessment (CSBA), telephone conversation with author, April 21, 2012.